lost through transfer to the FCC for commercial use; (2) the assumed spectrum-efficient technologies become available as needed; and (3) funds are provided by appropriations to implement the spectrum-efficient technologies into Federal radio systems.

The Subcommittee further concluded that spectrum should be requested near current public safety allocations, where feasible. Systems using new or emerging technology were not as sensitive to allocations, and could be located in bands removed from current public safety allocations.

The Subcommittee recommends that the FCC, in cooperation with NTIA, permit public safety services access to the following frequency bands, either by reallocation or by sharing. The frequency bands requested, in priority order are:

Voice, Data, and Video Requirements

1. Immediate further sharing of TV channels in the 470-512 MHz band in all areas.
2. Reallocate all or part of TV channels in 746-806 MHz band.
3. Immediate allocation of the VHF and UHF channels in other services created by the FCC's Refarming Proceeding (including TV sharing bands).
4. Eventual reallocation of all TV sharing channels in the 470 to 512 MHz band.
5. Immediate new sharing of the 174-216 MHz VHF TV band primarily outside of urban areas and for statewide systems.
6. Reallocation of the 380-399.9 MHz band.
7. Sharing of the 380-399.98 MHz band with DOD on a mutually agreeable basis to minimize interference to public safety operations.
8. Hold a portion of the 174-216 MHz band in reserve to meet future public safety needs, or needs not met by this effort.

Wide Band Data and Video Requirements

1. Allocations in the 1710-1755 MHz band.

Short-Range Video Requirements

1. Allocations in the 4635-4685 MHz band.

Fixed Service Requirements

1. Allocations in the 4635-4685 MHz band.
2. Allocations in the 1990-2110 MHz band.
3. Allocations in the 3700-4200 MHz band.

Intelligent Transportation Systems

1. Allocations in the 5850-5925 MHz band.

Interoperability

In addition to the spectrum requirements stated above, the Subcommittee recommends that channels be made available in a band below 512 MHz for nationwide interoperation among state, local and Federal public safety agencies. Specific details on spectrum requirements for interoperability are contained in the Report of the Interoperability Subcommittee.

System Sharing

The Subcommittee recommends that state and local agencies consider system sharing arrangements with Federal agencies within their jurisdiction. The Subcommittee further recommends that the FCC and NTIA encourage sharing arrangements, and amend applicable rules to permit flexible licensing and authorizations for shared systems using either Federal or FCC-controlled land mobile spectrum.

2.0.0 Spectrum Subcommittee's Charter Overview.

2.0.1 The primary mission of the Spectrum Requirements Subcommittee (SRS) is to examine the overall spectrum requirements of both Federal and non-Federal public safety agencies through the year 2010. To determine these spectrum requirements, the SRS has considered several factors, including population growth characteristics of the country and crime statistics. Additionally, the SRS has also taken into consideration previous public safety spectrum requirement studies coupled with the recommendations set forth in the Reports of the Operational and Interoperability Subcommittees.

2.0.2 As the demand for new commercial and noncommercial communications services increases, the amount of spectrum available for these competing services decreases. Importantly, therefore, the SRS has been asked to examine the impact of technology, the use of commercial services, and spectrum management options on the need for spectrum for public safety communication requirements.

2.0.3 The SRS also has the task of analyzing spectrum that is suitable for both Federal and non-Federal use by public safety entities to more fully meet existing communications requirements as well as new communication tools like transmitting fingerprints, mugshots, building diagrams, full motion picture, and a host of other high speed data applications. Factors such as existing Government and non-Government use of the bands, adjacent channel uses, and the propagation characteristics of the bands have been analyzed to determine the suitability of the bands for public safety use and for what potential services the identified bands can be used.

2.1.0 Report Scope.

2.1.1 The SRS has attempted to develop a long-term spectrum plan for both Federal and non-Federal public safety entities through the year 2010. This plan, hopefully, can be used by the

Congress of the United States, the FCC, and NTIA to assist them when addressing the spectrum requirements of critical public safety services through 2010.

2.1.2 Public safety entities have unique requirements for spectrum to support their many and varied missions. Leading the demand for additional spectrum to meet the requirements for enhanced public safety systems are high-technology mobile radio systems capable of transmitting — among other things — mugshots, fingerprints, building diagrams, and medical emergency data. The continued ability of public safety agencies to meet their responsibilities of serving the public welfare depends in large measure on the effective allocation of spectrum to meet these ever-growing communication requirements.

2.1.3 The SRS, to address the issue of spectrum planning for public safety, has reviewed the usage of current public safety allocations. It is clear that additional efficiencies may be gained in spectrum allocations below 512 MHz by the deployment of newer, advanced technologies in these bands. Because, however, these bands are highly fragmented, public safety licensees will continue to suffer severe spectrum shortages to meet existing and new communication requirements, including interoperability needs, unless spectrum relief is afforded and soon.

3.0.0 Background.

3.0.1 Telecommunications constitutes one of today's prime "leverage technologies." Throughout business, industry, and Government, the United States has increasingly relied on this technology to boost productivity, create new jobs and investment opportunities, and deliver more and better choices and services to the American public.

3.0.2 Telecommunications and information technology, linked together, thus constitute one of the most powerful and useful tools available to public policy makers today. They represent solutions to an array of challenges, and admit to widespread ubiquitous application. This is particularly true of wireless, radio-based communications that traditionally have proven one of the chief sources of productivity and efficiency gains.

3.0.3 Radio-based communications are also increasingly critical to the effective and efficient delivery of a wide range of important police, fire safety, emergency medical, and other public safety and related services. The costs of such services also represent a growing part of most state and local government budgets.

3.0.4 It is true that serious crime reported to U.S. law enforcement authorities has been declining. It declined by 2 percent in 1995 compared with 1994, according to the Federal Bureau of Investigation (FBI). This decline continued the trend from 1993, when overall crime was down 3 percent from the previous year. There were Crime Index decreases in all the nation's cities except those with populations of under 25,000 and 500,000 to 999,999. The greatest decline (6 percent) was recorded in cities with a population of one million or more. Rural law enforcement agencies reported a 3 percent increase. See FBI, Uniform Crime Reports, 1995 Preliminary Annual Release. Although the serious crime reported has declined, the demands for services continue to increase.

3.0.5 Public concern regarding the overall effectiveness of Federal, state, and local law enforcement efforts nevertheless is steadily increasing. Responding to these concerns, and ensuring that trends seen in recent years continue to show improvement, has required additional commitment by law enforcement professionals to improve their efforts. In most, if not all instances, this has entailed greater investment in and reliance upon radio-based telecommunications.

3.0.6 Fire safety is another field where government faces important challenges. In general, the number of fires reported to U.S. fire departments has declined slightly in recent years. Total as well as per capita fire losses have risen by nearly 10 percent annually, however, according to the most recent official statistics. In 1991, for example, total U.S. fire losses amounted to some $11.3 billion — $48.24 per capita. See 1994 U.S. Statistical Abstract at Table 348.

3.0.7 Response times are absolutely critical in fire safety, both to minimize property losses and, what is more important, potential loss of life. Average departmental response times also have a direct bearing on the casualty loss insurance premiums paid by property owners. Obviously, the more effective and efficient the wireless communications available to fire professionals, the greater the public welfare gains.

3.0.8 Response times are also clearly critical in the case of emergency medical services and, again, are essentially dependent upon the quality of the radio-based communications available to emergency medical service teams. Even fractions of a minute translate into significant additional lives saved, and often substantial reductions in subsequent medical treatment costs. Demand for emergency medical services, moreover, typically is a function of the age and thus the vulnerability of the population. At present, about one-third of Americans are aged 50 to 62, and the fastest growing part of the population are the elderly. How well emergency medical services are able to meet the needs of these communities obviously has a direct and immediate impact on their overall quality of life.

3.0.9 For many years, mobile radio in general and public safety communications specifically, ranked relatively low in terms of the FCC priorities. The centrality of broadcasting, especially broadcast television, overwhelmed the radio frequency process and the regulatory environment. Consequently, less than 100 MHz of radio spectrum was allocated to all mobile radio applications, and uses were scattered across a wide range of frequencies, thus necessitating multiple or expensive multi-frequency transceivers. Television broadcasters currently have more than 400 MHz of spectrum.

3.0.10 This scarcity of available frequencies limited the contribution that mobile radio services could make. It also had some beneficial consequences, however. In order to multiply the effective communications capacity of scarce channels, the public safety agencies had to find ways to use the frequencies more efficiently, usually by splitting their channels. On the Federal Government side of the radio frequency management equation, difficulties accommodating Federal public safety spectrum requirements have not been as apparent. This is the result of better cooperation among the Federal agencies and NTIA than exists between public safety and private sector users (through the FCC), prompt implementation of

narrowband channeling (12.5 kHz), periodic re-evaluation of frequency assignments, and stringent receiver standards. All these factors allow Federal agencies to better meet their increasing spectrum requirements in their limited spectrum resources.

3.0.11 Mobile radio, particularly in the public safety arena, is an area where spectrum scarcity and relatively few equipment buyers (and suppliers) shaped the market.

3.0.12 From the inception of mobile radio services in the 1930's, however, Government policy has generally sought to promote competitive marketplace solutions. Advances and public dividends are a function of Government consistently striving to reduce rules and regulations, and actively seeking to foster actual and potential, private sector competition.

3.0.13 Obviously, not all issues and choices can be — or, indeed, should be — made solely on the basis of competitive and de-regulatory considerations.

3.0.14 If, however, there is a single lesson to be gleaned from America's positive experience in communications over the past two decades, it is that less almost always has meant more. Fewer Government rules, more reliance on individual decision making, and more confidence in the ability of competitive private enterprise to evolve sound marketplace solutions have all fostered competition. That competition, in turn, has spurred innovation and greater customer responsiveness. The result has been significant unarguable national gains. The Government's role during these changes was to ensure that interference potential between the many divergent spectrum users was reduced.

3.0.15 Fundamentally at issue today are how much competition, choice, and individual decision making makes sense in public safety communications. Congress recently overhauled much of the 1934 Communications Act, as amended, 47 U.S.C. Sec. 151 et seq. The Telecommunications Act of 1996, Public Law No. 104-104, 110 Stat. 56, approved February 8, 1996, directs major, pro-competitive, and deregulatory change throughout the regulated telephone, television, radio broadcast, and cable television sectors. That legislation rests on the assumption that competitive markets will achieve solutions as effective, if not more effective, than those which Government might otherwise mandate and impose.

3.0.16 One major area of communications, a critical area of communications, was not directly affected by that landmark legislation — public safety communications. This is not to say public safety communications issues and choices are not critical, however.

3.0.17 The preamble to the 1934 Act ranks "promoting safety of life and property" second only to fulfilling national defense requirements. Certainly Congress will expect any regulatory action in this area to be fully consistent with the overall pro-competitive, pro-choice, pro-"devolution" thrust of the major legislation it just passed.

3.0.18 In recent years, public safety communications groups have successfully urged their requirements be seriously studied. Section 6002 of the Omnibus Budget Reconciliation Act of 1993 directed the FCC, in February 1995, submit to Congress a review of current and future state and local government public safety communications needs through the year 2010.

The FCC was also directed to develop a plan to ensure adequate frequency spectrum would be available to meet those requirements.

3.0.19 In March 1995, Congressman Harold Rogers, Chairman of the House Appropriations Subcommittee on Commerce, Justice, State, and the Judiciary, expressed concern that the Commission's response to the 1993 Act requirement had been inadequate. Chairman Rogers requested the issue of the amount of spectrum available for Federal as well as state and local public safety communications be carefully and systematically addressed. Subsequently, the Commerce Department's NTIA, which is responsible for managing the use of spectrum by Federal agencies pursuant to Section 305 of the Communications Act, and the FCC jointly established the Public Safety Wireless Advisory Committee (PSWAC).

3.0.20 The PSWAC membership is drawn from all parts of the public safety communications field, including users, regulators, national associations, equipment suppliers, and members of the public. Participating on the subcommittees and steering committee are officials of many Federal agencies as well.

3.0.21 Public safety communications is a generic term. It encompasses the wireless systems used by Federal, state, and local users. They include law enforcement, fire safety, emergency medical service, emergency preparedness, disaster relief, and other important subject areas.

3.0.22 Traditionally, Federal radio frequency management in this field has apportioned spectrum — radio channels — on a relatively rigid and inflexible basis. Channels have been earmarked for discrete, individual services. The channels apportioned to fire safety systems, for example, have not generally been available for local law enforcement use. Likewise, channels used by public utilities, road crews, and those used to support Federal law enforcement have been essentially "off-limits" to state and local public safety agencies.

3.0.23 Government policy has done little to date to change the inefficiencies brought about by the separate and distinct frequency management systems employed by both the Federal and non-Federal users. Likewise, Government policy has done little to encourage the development of interconnected, "public" or common-user radio networks. Consequently, the proliferation of radio systems too often necessitates multiple transceivers in public safety vehicles. Partly as a function of the relatively inefficient way in which spectrum resources have been allocated, urban police vehicles, for example, too often display "more antennas than an old Soviet trawler," as one critic put it.

3.0.24 Moreover, there has been a trend toward more and more customized, user-specific, public safety communications systems. Customization has helped public safety communications users more closely tailor their systems to specific needs. Customization may also be a function of the limited spectrum available to public safety agencies, and the tradition of licensing public safety agencies separately. But, that very customization that may optimize achievement of some missions has come at a significant cost.

3.0.25 Public safety communication devices have not decreased in cost over the years. Thirty years ago, a 100-watt mobile radio would use standard squelch, had one channel, and cost

more than $1,000. Today that same radio would cost less than $500. But today, public safety agencies don't buy that type of radio. Today's radio uses some form of squelch control. It has several channels and it is common to have either a scan feature or a second channel monitor to increase the efficiency of the public safety personnel. Enhanced scrambling is often requested. The radio is all solid state, uses less vehicle power, and is much smaller to fit in the reduced size of vehicle trunks. These features are required to meet the challenges of "Working Smarter" and meeting the ever increasing demands for service. All these features distort the cost picture. The bottom line is demand for features has increased, not the basic cost of the radio.

3.0.26 Moreover, serious network interconnection and interoperability issues have arisen and persisted. Such issues typically arise when state or local public safety communications users endeavor to communicate with nearby jurisdictions or Federal users, usually in a disaster context (e.g., an airplane crash). In part, this incompatibility is a function of the different frequencies used by public safety and, in part, it may be a function of differing regulatory schemes. Federal spectrum users are authorized by NTIA; non-Federal users are authorized by the FCC. Each group of users may employ different frequencies and there is little, if any, coordination between the licensing agencies. However, it is important to note that if separate agencies used the same frequency all the time, channel loading could be increased to the point the channel would be unusable for both parties. Increased emphasis on better cross-banding and cross-patch services would facilitate interoperability between distinct users when required.

3.0.27 Public safety communications has encountered legitimate criticism in recent years. Questions have been raised regarding the cost-effectiveness of various systems and planned systems. Some of this criticism is no different from that which other government institutions have encountered in recent years, and reflects a growing concern on the part of taxpayers and elected officials that they get a fair value for their money.

3.0.28 Public safety communicators thus confront a diversity of institutional and regulatory pressures. Public safety communications operations are not immune from budget cutting. No longer are public safety operations, including law enforcement, necessarily deemed "sacred cows" that are immune from budget cutting. Indeed, both at the Federal and state and local levels, there have been reductions in public safety and law enforcement funds.

3.0.29 What this has meant is growing pressure on public safety communications managers to use their radio channels more efficiently. In this regard, that same familiar convergence of modem communications and computer technology that has reshaped so much of the U.S. wireline telecommunications industry is also reshaping the way public safety and other wireless communications is undertaken today.

3.0.30 The central reality of this convergence process is the supplanting of traditional analog communications techniques with digital systems tied into computers, a transition that holds much radio spectrum management promise. Digital technology facilitates use of far narrower channels or more capacity: a given bandwidth can handle substantially greater use. In short, digital today means substantially more efficient spectrum use — a clear plus from an overall frequency management perspective, given escalating demand today for spectrum generally and

more complex public safety communications requirements. However, without establishing common interface standards for digital services, the interoperability problems that currently exist will worsen.

3.0.31 An NTIA Report, entitled *U.S. National Spectrum Requirements: Projections and Trends* (April 1995) (hereinafter called *NTIA Spectrum Requirements Study*) found additional spectrum was needed to satisfy users requirements in a variety of different radio services, including public safety. As noted in the NTIA Report, all the identified services are important to the nation and it is difficult to determine which services deserve spectrum and how much. Congress, however, has repeatedly mandated that the FCC must give "top priority" to the needs of those users who "protect the safety of life and property."

3.0.32 The SRS has found that forecasting the demand for spectrum for public safety has been difficult at best. It is clear, however, that increasing demands are being placed on public safety entities at all levels, especially in major metropolitan areas, for more and better services. The SRS has concluded that additional spectrum must be set aside for public safety entities at the Federal, State and local levels to support law enforcement, fire, emergency medical, forestry-conservation, highway maintenance and other public safety services.

3.0.33 Additional spectrum, standing alone, however is not enough to meet ever increasing demands on public safety agencies. Long-term spectrum planning is also critical for the effective management of radio spectrum allocated for public safety use, including more efficient use of current spectrum allocations. Accordingly, in this Report, the SRS has identified a number of spectrum management options that, if implemented, will improve spectrum by Federal and non-Federal public safety entities. The SRS believes the use of future commercial services by public safety agencies will play a major role in public safety agencies using their allocations more efficiently and effectively for critical public safety communications requirements.

4.0 Current Spectrum Allocations and Usage.

4.1 Introduction. Spectrum management authority in the United States is shared between the FCC and the President. The Communications Act of 1934 established the Commission and gave it authority to assign frequencies to radio stations, except for Federal Government owned or operated radio stations. Section 305 of the Act preserves for the President the authority to assign those frequencies. These powers are currently delegated to the Assistant Secretary of Commerce for Communications and Information who is also the Administrator of the NTIA. The FCC is composed of five members, who are appointed by the President with the advice and consent of the Senate. The Interdepartment Radio Advisory Committee (IRAC), which is composed of twenty Federal departments and agencies, serves in an advisory capacity to the NTIA's management of the electromagnetic spectrum. The Act provides for the function of developing classes of radio service, allocating frequency bands to the various services, and authorizing frequency use. However, the Act does not mandate specific allocations of bands for exclusive Federal or non-Federal use; all such allocations stem from agreements between NTIA and the FCC.

Use of the radio spectrum is vital to the security and welfare of the Nation. Sufficient mobile communication capacity for agencies charged with protecting the public welfare is of critical importance.

4.2 Non-Federal Public Safety Allocation and Usage.

CURRENTLY ALLOCATED PUBLIC SAFETY LAND MOBILE SPECTRUM
Non-Federal Government

Frequency Band (MHz)	Number of Channels	MHz (Approximate)
25-50	315	6.3
150-174	242	3.6
220-222	10	0.1
450-470	74	3.7
806-821/851-866	70	3.5
821-824/866-869	230	6
TOTAL*	**941**	**23.2**

*Various amounts of spectrum have also been allocated in the 470-512 MHz band in 11 markets: Boston, Chicago, Dallas, Houston, Los Angeles, Miami, New York, Philadelphia, Pittsburgh, San Francisco, and Washington, D.C.; ranging from 6 to 18 MHz. (In Los Angeles, 6.5 MHz is allocated.)

4.3 Federal Spectrum Allocation and Usage.

LAND MOBILE SPECTRUM Federal Government		
Frequency Band (MHz)	Uses	Remarks
30-50	Dispatch	Conventional
138-144	Dispatch	Military
148-149.9	Dispatch	Military
150.05-150.8	Dispatch	Military
162-174	Dispatch	Conventional and trunked
220-222	Dispatch	Conventional
406.1-420	Dispatch	Conventional and trunked

These bands support many Federal land mobile functions, of which public safety (law enforcement, fire, medical, etc.) is only a part.

5.0 Demographics. Impact on Need for Additional Spectrum.

5.1 Introduction. Section 9 defines the spectrum needs of public safety based upon the population of public safety users and their radio units in a particular geographical area. The number of users depends upon the total citizen population of the geographical area. As the Census Bureau tracks residential populations and their data are readily available, Census Bureau data will be used to estimate the total citizen populations for population centers of about 50,000 inhabitants and greater and relate citizen populations with public safety users.

5.2 Current U.S. Demographic Characteristics. A statistical description used by the Office of Management and Budget (OMB) provides an understanding of how to classify urban and rural. OMB divides the United States into county-based Metropolitan Statistical Areas (MSAs) and nonmetropolitan areas. A county is included in an MSA if:

1) it contains a city with a population of at least 50,000; or

2) it contains an urbanized area[1] with a population of at least 50,000 and a total metropolitan population of at least 100,000; or

3) it has strong economic and social ties to a central county containing the main city or urbanized area.

For example, the Colorado Springs, Colorado MSA includes a single county with a single large city. The Indianapolis, Indiana MSA includes a single large city located in Marion County, but it also includes eight surrounding counties that are relatively densely populated. The Las Vegas, Nevada MSA includes a single large city located in Clark County, but it also includes sparsely populated Nye County. Ten counties in the state of Iowa are included in MSAs, but the remaining 89 counties are considered nonmetropolitan.

According to 1994 population estimates, approximately 80% of the total U.S. population of 259.6 million people live in MSAs (Rand McNally, 1995). The remaining 20%, 52.4 million people, live in nonmetropolitan counties. Nonmetropolitan counties, however, comprise approximately 80% of the land area in the country (U.S. Bureau of the Census, 1994).

Some counties included in MSAs contain portions that are sparsely populated and located a considerable distance from the nearest city. Estimating spectrum needs on a large population spread over a large MSA land area could give wrong results compared with estimating the needs of the same population over a much smaller land area associated with a densely populated metropolitan center. To provide a better estimate of spectrum needs, a metric other than that defined by an MSA is needed which ties population more closely to the land area where the population resides.

Attempts have been made by non-OMB demographers to more clearly separate urban and rural areas. One such definition by Rand McNally, called Ranally Metropolitan Areas (RMAs), includes only sub-counties in their definition and by their estimate, "RMAs that approximate MSAs comprise about 92% of the MSA population although only about 28% of the MSA area." Currently Rand McNally has defined 452 RMAs with populations of about 50,000 and greater.

Appendix A gives the data available from Rand McNally's Ranally Metropolitan Area population data. Each RMA is identified by the major city within the RMA and population values are given for the RMA's metropolitan area, the RMA's central city(ies), and the suburban area associated with the RMA. The land areas in square miles are provided for the metropolitan and central city of each RMA. Population figures are listed from the April 1, 1990 Census and estimated populations are for January 1, 1994. The percent change over the four-year period is given for the metropolitan area, the suburbs, and the central city(ies) of each RMA.

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[1] According to the Census Bureau, an urbanized area consists of a central city and the contiguous, closely settled area outside the city(ies) political boundaries.

5.3 Projected Demographic Data. Population projections are made for 2010 by using the historical population change from 1990 to 1994 listed for each RMA. In some cases the population changes from 1990 to 1994 were of greater percentage for cities than those for their metropolitan area. Projecting the growth of the city versus the metropolitan area in some cases resulted in a city population greater than the metropolitan population. In Appendix A, the 2010 population estimates were first based upon the metropolitan projection and the associated city population projection was constrained to not exceed the metropolitan projection.

6.0 Spectrum Management Options for Increased And/or More Effective Use of Current and Future Spectrum Allocations.

6.1 There is growing pressure on Federal and non-Federal public safety communications managers to use their radio channels more efficiently. As demonstrated elsewhere in this Report, there is a need for additional spectrum to support public safety agencies at all levels. There is also a need for better long-term planning and better management of the radio spectrum allocated for public safety use.

6.2 The Spectrum Requirements Subcommittee observes that the Transition Subcommittee Report discusses several spectrum management proposals that may lead to more effective and efficient use of spectrum allocated for public safety uses. These include transitioning to exclusive licensing, encouraging spectrum sharing between public safety agencies, developing regional plans to manage spectrum allocations, privatizing licensing functions currently performed by the FCC, increasing the use of electronic filing and processing of public safety applications, and increasing the role of States in the spectrum management process. The SRS also believes these proposals can lead to better management and use of public safety spectrum allocations. The SRS thus recommends the FCC and NTIA fully evaluate the Transition Subcommittee's suggestions and implement those they determine will improve the management of the radio spectrum within their respective jurisdictions.

6.3 The SRS further recommends the FCC and NTIA undertake joint planning efforts to improve management of spectrum allocated for public safety purposes and to assure it is used efficiently. For decades, use of spectrum by Federal Departments and Agencies has been managed by the President and his designee; the use of spectrum by non-Federal public safety agencies has been managed by the FCC. These separate systems have, in the past, served their constituencies well.

6.4 As the demand for scarce spectrum has grown, however, Government policy has done little to change the inefficiencies brought about by the separate and distinct frequency management systems employed by NTIA and the FCC. The SRS therefore also recommends the NTIA and FCC establish a joint study group to further discuss and evaluate how their separate and distinct spectrum management systems can be improved to the benefit of public safety agencies and, ultimately, the public-at-large. The SRS believes this joint spectrum planning effort should be undertaken and completed within twelve months of the date of completion of the PSWAC Report.

6.5 Similarly, it may be advisable to establish an advisory process between Federal and non-Federal public safety users to evaluate and consider the wide variety of issues that face public safety agencies at all levels of operation. Increasingly, there are requirements for communication between different Federal and non-Federal public safety agencies. Moreover, substantial efficiency gains could be achieved by sharing spectrum and infrastructure by Federal and non-Federal agencies. The SRS notes, for instance, the State of Wisconsin and the Department of Defense are currently planning the development of a joint, multi-agency VHF trunking system that has the potential for dramatic improvement over the systems currently in use. More such efforts should be encouraged and there should be put in place a mechanism where such sharing can occur with the minimum of Government "red-tape."

6.6 The SRS also recommends the FCC and NTIA study and evaluate methods to consider the multiplicity of operational and licensing issues that confront Federal and non-Federal public safety agencies on a day-to-day basis. Here again, the objective should be to improve the coordination between the Federal managers and the user community. In the short-term, improvements in coordination between the FCC and NTIA and various user groups could be accomplished by placing FCC/NTIA representatives on the Public Safety Communications Council, a private organization whose membership is composed of various public safety user groups.

7.0 Impact of New Technology and Commercial Services On the Spectrum Needs of Public Safety Communications.

7.1 Introduction. In this section, we will investigate the magnitude of the impact of technology and the use of commercial services on the spectrum need computed in Section 9.0. It will be shown the parameters used for the spectrum computation herein are very aggressive, and, in fact, that a paradigm shift will be necessary to effect the projections made.

7.2 Technology Subcommittee Input. The Technology Subcommittee provided the expected state-of-the-art for the average installed system in 2010 as part of the basis for generating spectrum estimates. The Technology Subcommittee has stressed these technology estimates are quite aggressive - **thus any spectrum estimate based upon them will be correspondingly conservative.**

7.2.1 An Example. The technology forecast provided estimates that the public safety voice radio system in use in the year 2010 would require **an average of** 4 kHz of spectrum per active conversation.[2] Realistically, this high level of efficiency could only be achieved by universal replacement of existing equipment and the widespread deployment of public safety systems more spectrum efficient than any on the market today.

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[2] The value of 4 kHz per voice channel is based on an offered load of 6 kb/s for digitized voice today, and by the year 2010, an improvement in coding of 2:1, the use of error correcting code and overhead that requires double the offered load, and a transmitted rate (or modulation efficiency) of 1.5 b/s/Hz.

7.2.2 Impact of Projection. To put this requirement in perspective, assume that the older one-fourth of installed equipment in 2010 operates with a spectrum efficiency of 12.5 kHz per speech path (the level required for new type acceptances today under the FCC's refarming rules, but not yet in significant use in public safety). Then, if the forecasts of the Technology Subcommittee are to be met, the other three-quarters of equipment must operate with a spectrum efficiency of 1.17 kHz per speech path (roughly twenty times more efficient than today's typical practice). This discussion considers one specific technological element, voice transmission. The forecasts were similarly aggressive in other areas such as data modulation, video coding improvement, etc.

7.3 Use of Commercial Services: Impact on Spectrum Needs of Federal/Non-Federal Public Safety Agencies.

7.3.1 Since most commercial mobile radio services are fundamentally designed to meet the needs of private sector customers and/or individual consumers, they do not all offer levels of customized service required for certain applications in the public safety environment.

Those requirements include the need for instant push-to-talk group dispatch, priority access, and security. Agencies that are concerned about inter-jurisdictional communications need to ensure that if they use commercial services, they are able to work with vendors that provide interoperability with other vendors and/or have plans to interface with private systems, ensuring ubiquitous coverage to the largest degree possible.

Public safety organizations engage in a wide variety of activities in their mission to protect life, property and to provide for public safety. Like any other public or private sector organization, their activities range from those that are mission-critical to those that are more subordinate in nature. The communications needed to support these activities are similarly wide-ranging, and offer differing operational capabilities. The gap between what is required by public safety and what can be delivered by commercial wireless services is widest among mission-critical communications like "shoot, don't shoot" scenarios, and narrowest among subordinate applications, like routine background checks.

Public safety private systems are primarily designed to handle high priority, mission-critical communications. A properly designed private system should be able to accommodate all mission-critical communications during peak load periods, and have excess capacity during off-peak load periods to accommodate subordinate communication applications as well.

If subordinate communication applications can be retained on private systems, agencies can leverage their infrastructure investment and fill available system capacity. On some networks, the system manager is able to control radio traffic to ensure that mission-critical communications get through during peak load periods, while subordinate types of communications are postponed until capacity is available. When subordinate communications become postponed on a regular basis however, alternatives should be considered.

Since private systems provide what is required by public safety agencies for mission critical applications, subordinate applications become the strongest candidates for outsourcing to

commercial wireless services. When agencies migrate applications to commercial services, an examination regarding the cost/benefits of outsourcing should be conducted. Outsourcing makes sense when the benefits versus the cost of commercial services reach a "break-even" or positive gain over using a private network. If subordinate communications are continuously postponed or unavailable due to priority preemption, user productivity and responsiveness can suffer. Costs associated with time loss and the inability to accomplish desired results may be many times the cost of outsourcing. A migration plan to commercial services is best suited for agencies consistently nearing or exceeding capacity beyond peak traffic hours. An outsourcing "back-up" plan should be sufficient when extenuating circumstances require occasional additional capacity.

Based on feedback received from individual agencies to the Interoperability Subcommittee, and estimates by private network manufacturers, 10% of the current applications running on private networks are candidates for outsourcing (Appendix B). Whether that outsourcing is required for occasional preemption or whether the need is for all subordinate communications has not been explored. However, growing demand for private spectrum to support customized applications specific to public safety will encourage agencies to explore commercial options for subordinate applications as private spectrum fills.

7.3.2 Spectrum Relief

7.3.2.1 Public safety agencies are increasingly finding new roles for commercial services which did not previously exist, yet substantially lighten the load for dispatchers, by directing routine traffic to alternate, commercial spectrum.

7.3.2.2 The Alexandria, Virginia, Police Department (PD) provides a good example of how moving to a commercial data service can relieve an overcrowded voice channel. According to PSWAC/ISC 96-04-036, notes from a meeting at the Alexandria Police Department Headquarters, a cellular digital packet data (CDPD) system is under current evaluation as part of a pilot test. A CDPD network will be used to support laptop/notebook computers with wireless modems for data transfer. According to the report:

> *"The Alexandria PD representative stated that the system initially will be used to request tag checks, wants and warrants, which are currently handled on a voice channel through the central dispatcher, who then accesses the data base in Richmond. The Alexandria PD currently operates on one dispatch channel and it routinely becomes overloaded during peak traffic periods. This creates delays of up to fifteen (15) minutes to get a routine license check called in to dispatch, and depending on the dispatchers' traffic load, the response back to the officer does not conduct a query due to the time required to get on the channel. They feel the use of CDPD, will help to minimize both problems, first it should reduce the voice traffic by at least 30%, while reducing the response time of such data queries, and second, the officers will accomplish more queries, which they feel will increase the capability to recover stolen vehicles and apprehend offenders. The response time experienced during the test has been two (2) to three (3) seconds from the time an officer inputs the data until the time he/she receives the response."*

additionally,

> *"Officers will eventually utilize the system to provide incident reports from the scene, which will relieve some of the officers' administrative burden, as well as possibly further reduce voice traffic by as much as another 15-30%."*

7.3.2.3 Groton, Connecticut Police Department uses CDPD with mobile data computers for messaging and to query the National Crime Information Center. Public safety officials can wirelessly exchange forms or messages from their vehicles or desktops within seconds. Previously, if an officer needed certain information, he/she had to call into the dispatch operation to get someone to pull the data and then relay it verbally. This was a slow process and discouraged people from asking for what they needed.

8.0 Review of Previous Spectrum Management Studies.

8.0.1 As previously observed, long-term spectrum planning is critical if the spectrum requirement needs of Federal and non-Federal public safety entities are to be met now and in the foreseeable future. Forecasting the spectrum requirement needs of public safety agencies has been undertaken on several previous occasions. In August of 1985, for instance, the FCC released a staff *Report on Future Public Safety Telecommunications Requirements* indicating at least 12.5 MHz to 44.6 MHz of spectrum would be needed for public safety use in twenty-one major metropolitan areas by the year 2000.

8.0.2 In December of 1993, the Coalition of Private Users of Emerging Multimedia Technologies (COPE) submitted a petition to the FCC requesting an allocation of 75 MHz for the development of advanced private land mobile radio systems. This spectrum request was to meet the unique needs of the private land mobile radio users for advanced wireless imaging and decision processing/remote file access capabilities. COPE's request was for an allocation of spectrum below 3 GHz, in the vicinity of the 2 GHz band.

8.0.3 In August of 1994, the Association of Public Safety Communications Officials International, Inc. (APCO) also filed with the FCC a study, entitled *Public Safety Spectrum Needs Analysis and Recommendation*, concerning the specific spectrum needs of non-Federal public safety agencies. APCO found that an additional 12 MHz of spectrum is required in metropolitan areas, with another 6 MHz of spectrum required nationwide, "just to keep pace with the demand for basic voice and data communications." APCO also maintained that at least 25 MHz of additional spectrum would be needed by the year 2000, and another 50 MHz by the year 2010, to permit law enforcement and other public safety agencies to implement a vast array of new telecommunications technologies.

8.0.4 The *NTIA Spectrum Requirements Study*, as previously observed, also found that eight land mobile radio services, including public safety, would need access to additional spectrum to satisfy user requirements to the year 2004. More specifically, the *NTIA Spectrum Requirements Study* found that 204 MHz of spectrum is required for land mobile services in the next ten years, including 50 MHz for new advanced private land mobile radio services like public safety.

8.0.5 The general consensus gleaned from these studies is that there is now and will continue to be insufficient mobile communications capacity (i.e., spectrum) for public safety agencies to meet their critical and essential responsibilities to protect the public welfare.

9.0 Spectrum Need Projections.

9.1 Introduction. The projection of the amount of spectrum needed by the public safety community through the year 2010 has been a cooperative effort in PSWAC with each Subcommittee contributing to the process in the area of their special interest. Careful consideration was given by each Subcommittee to the state of the art at this time, and projections were made, where possible based on past history, to provide the best estimate possible of the growth of wireless technology in the public safety community.

Section 9.3 provides the input of the SRS to the model, and then the model that was used to make the projection is described. Section 9.2 describes the input of each of the other Subcommittees as it relates to this projection. This information is then summarized in Section 11.0 where the conclusions of the analysis are presented.

9.2 Subcommittee Inputs.

9.2.1 Operational Requirements Subcommittee. In Annex B of their Report, the Operational Requirements Subcommittee provided the population (POP) of public safety personnel and the percentage of the identified population that will use a particular type of radio communication (PEN).

9.2.2 Technology Subcommittee. In Appendix C of their Report, the Technology Subcommittee provided RF transmission rates (RATE); error control and overhead (ERR); source content (SRC); channel occupancy (LOAD); and coding improvements (COD).

9.2.3 Interoperability Subcommittee. The Interoperability Subcommittee provided the number and use of channels required for Federal, state, and local interoperability communications.

9.3 Spectrum Requirements Subcommittee Analysis of Spectrum Required.

9.3.1 Description of Model Used. Working Group 8 (WG-8) of the SRS was chartered to evaluate a model proposed by Motorola in its White Paper first submitted on February 2, 1996, and to make any changes that would prove necessary. The resulting model was then to be used, with input from all Subcommittees, to project the spectrum need of the public safety community through the year 2010. The model that has evolved is fully described in the White Paper included as Appendix C. Select portions will be described here to provide a working knowledge of the model.

An engineering methodology for projecting spectrum needs that is independent of any manufacturer's product was incorporated into the model. This is only reasonable, since the products that will be available by the year 2010 have probably not been invented at this time.

A methodical approach is used to project the trends of key technologies that relate to spectrum need. The relationships between operational need and required spectrum are described in terms of technical parameters in a mathematical equation, the model. That model is used to predict future spectrum requirements. This methodology is derived from that in the Coalition of Private Users of Emerging Multimedia Technologies (COPE) petition[3] and has been successfully employed in the work of others.[4]

The steps to be used in the development of the model, and the resulting parameters, are:

9.3.1.1 Identify Geographical Area. Identify the geographical area over which the model will be applied and the population of public safety personnel who will use the services to which the model applies. Any major metropolitan area will serve the needs of this analysis. A larger area will involve the selection of a larger geographical reuse parameter, described in Appendix C. A smaller area will have a proportionally smaller reuse parameter. Thus, the selection of a particular geographical area does not limit the generality of this process. The geographical area that will be used is the greater metropolitan area of Los Angeles, California.

9.3.1.2 Identify Advanced Services. Identify the advanced services that will be used by the public safety community through the year 2010.

The detailed advanced services which have been considered are:

- voice dispatch
- telephone interconnect
- transaction processing
- facsimile
- snapshot
- decision processing/remote file access
- slow scan video
- full motion video

These services have been summarized into the following five for purposes of detailed computation:

- Voice
- Data
- Status/Message

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[3] Coalition of Private Users of Emerging Multimedia Technologies (COPE), FCC Petition for Rule Making, Spectrum Allocations for Advanced Private Land Mobile Communications Services, filed 12/23/93. COPE represents many private users of land mobile radio, including public safety organizations such as APCO and the PSCC.

[4] Joint Comments of Advanced Mobilecom Technologies, Inc. and Digital Spread Spectrum Technologies, Inc. to the FCC in General Docket No. 90-314 in the matter of Amendment of the Commission's Rules to Establish New Personal Communications Services, dated January 29, 1993.

. Wide Band Data
. Video

9.3.1.3 Identify Technical Parameters. Identify a self-consistent set of technical parameters that can relate the spectrally efficient usage of the advanced services to the spectrum required. The chosen parameters are:

. Population (POP) of public safety personnel
. Penetration (PEN) of service into the population, (%)
. Average offered load (ERL) per officer, Erlangs
. Source (SRC) content today, kbits/sec
. Expected coding (COD) improvement factor
. RF transmission rate (RATE), bits/sec/Hz
. Error (ERR) control and overhead, % of transmission
. Average busy hour channel loading (LOAD) factor determined from Erlang theory, %
. Geographic reuse (REUS) factor
. Spectrum used today

9.3.1.4 Quantify Technical Parameters. Quantify these technical parameters with the best information that is available at the present time. A Unified Traffic Model has been used to quantify the offered load. A detailed description is contained in Appendix D. The category of Special Data described therein has been broken into two categories for this report, Wide Band Data and Video, and the offered load has been refined downward based upon more recent information that has been obtained through the Focus Groups process (Appendix E). Other parameters have been quantified by reference to the curve trends in Appendix C, and others by reference to handbooks and reports as described in the various Subcommittee reports contained herein. The state of the art technologies in the year 2010 have been quantified, as described above. However radio equipment has a useful life that is often in excess of 10 years, some of it 15 years and longer. So, by the year 2010, there will be a distribution of equipment on the street with a range of spectral efficiencies. It is also reported that some agencies warehouse old equipment that is in operating condition for use under extreme conditions when there are unusual concentrations of personnel. Thus, the parameters which are used in the model represent an integration of the parameters that are projected to be in use in equipment in the 2010 time frame.

As described previously, the geographical area chosen for this analysis was the greater Los Angeles metropolitan area. However, it was not possible to conduct a detailed analysis of the population of public safety personnel in the allotted time. However, an analysis of a comparable area around New York City, NPSPAC Region 8, was available and is contained in Annex B of the Operational Requirements Subcommittee Report. This material provides the population of citizens in the area as well as the public safety users divided into the services of Police, Fire, Emergency Medical Services (EMS), and General Government. The population of citizens was available for the Los Angeles area (most of NPSPAC Region 5); therefore, the public safety population was assumed to be the ratio of citizens in Los Angeles to the citizens in New York City multiplied by the public safety personnel in New York City.

The penetration of the radio services being considered into the total population of potential users was also not available for the Los Angeles area. Again, a detailed analysis was available from New York City, and is contained in Annex B of the Operational Requirements Subcommittee Report. That penetration was used directly as input to the model.

Table 9.1A
Parameters That Apply to All Users

SERVICE	SOURCE CONTENT,kb/s	CODING IMPROVEMENT	TRANSMISSION RATE, b/s/Hz	CHANNEL LOADING	REUSE FACTOR	ERROR CODE & OVERHEAD,%
Voice	6	2	1.5	54.5	2.5	50
Data	6	1	1.5	54.5	2.5	50
Status/ Message	6	2	1.5	54.5	2.5	50
Wideband Data	384	3	3.5	54.5	4	50
Video	384	3	3.5	54.5	4	50

Table 9.1B
Parameters That Apply to Separate Functions

SERVICE	OFFERED LOAD IN ERLANGS	POPULATION, THOUSANDS	PENETRATION IN PERCENT
POLICE			
VOICE	0.0538	89.4	65
DATA	0.0087	89.4	35
STATUS/MESSAGE	0.0004	89.4	31
WIDEBAND DATA	0.0140	89.4	23
VIDEO	0.0240	89.4	14
FIRE			
VOICE	0.0484	164.7	51
DATA	0.0087	164.7	27
STATUS/MESSAGE	0.0004	164.7	31
WIDEBAND DATA	0.0140	164.7	28
VIDEO	0.0240	164.7	20
EMS			
VOICE	0.0484	55.8	47
DATA	0.0087	55.8	45
STATUS/MESSAGE	0.0004	55.8	34
WIDEBAND DATA	0.0140	55.8	31
VIDEO	0.0240	55.8	17
GENERAL GOVT.			
VOICE	0.0430	269.8	22
DATA	0.0087	269.8	1
STATUS/MESSAGE	0.0004	269.8	16
WIDEBAND DATA	0.0140	269.8	1
VIDEO	0.0240	269.8	3

9.3.1.5 Assumptions. In any model such as this spectrum need projection, there are assumptions that are necessary, if only because the future is not assured. In the paragraphs to follow, we will first list the assumptions that apply to the model in general, followed by

those that relate to specific parameters. In the latter case, the source of the data that allowed quantification of the model will also be indicated.

9.3.1.5.1 Global Assumptions.

1) It is assumed there are delays between the availability from manufacturers of more spectrally efficient radios and the actual implementation and use of these radios in the marketplace that result in the distribution of voice and data radios in the year 2010.

2) The applications used on networked desktop computers will be required in wireless form by public safety officers in the future.

3) Historical trends of semiconductors, data compression, and wireless technology will continue the established trends reported in the Technology Subcommittee Report through the year 2010.

4) Spectrum will be made available in a timely manner so that volume sales of wireless advanced services will bring the cost down to within the budget constraints of most public safety users.

5) The requirement for presently unidentified future services will have a negligible impact on spectrum need through the year 2010.

9.3.1.5.2 Parametric Assumptions.

1) OFFERED LOAD, ERLANGS. The traffic profiles for a "hypothetical Law Enforcement/Public Safety organization employing both digital voice and digital multimedia services" are quantified for both present and future uses in the Immigration and Naturalization Service (INS) White Paper in Appendix D. This data is developed from an aggregation of existing Federal, state, and local law enforcement information and was logically extrapolated into the future. Wide band data and video are assumed based on current estimates of potential utilization should spectrum be made available. The future usage was further refined by the SRS based on input from the Focus Groups as reported in Appendix E and the Operational Requirements Subcommittee.

2) POPULATION. The population of public safety users was obtained from a detailed study of NPSPAC Region 8 which contains the City of New York. The study is contained in Annex B of the Operational Requirements Subcommittee (ORS) Report. It is assumed therein that the population of public safety personnel per citizen will follow the population density of citizens over time.

A similar study was started for NPSPAC Region 5 which contains Los Angeles. However, there was not sufficient time to complete that study for this final Report. It is assumed the distribution of public safety users will be similar to that of the New York area, so the detailed public safety demographics of New York were scaled to the total population of Los Angeles in 2010.

3) PENETRATION. The penetration of the services that have been identified for the public safety officers in the year 2010 was also determined in a study of NPSPAC Region 8. The study is contained in Annex B of the ORS Report. The penetration was determined by conducting interviews with a sample of communications officers representing over 47 percent of the public safety users. It is assumed the rest of the New York area users follow the distribution of the sample. Again, a study was started in the Los Angeles area, but it was not available in time for this Report. The New York penetration was used, and it is assumed the penetration into Los Angeles will follow that of New York.

4) SOURCE LOADING. The data rate for voice, data and status message is taken from the INS White Paper in Appendix D where it is assumed to be 750 B/s (6 kb/s). This is not inconsistent with the values proposed in the Motorola White Paper in Appendix C. The data rate for wide band data and video is taken from the Motorola White Paper where the status of the state of the art is reviewed and the average at this time is determined. These values were then confirmed by the Technology Subcommittee.

5) CODING IMPROVEMENT FACTOR. The Motorola White Paper was referenced for this parameter as well as the Technology Subcommittee report for the state of the art that will be available in the 2010 time frame. The value used for the computation is an assumed value based upon the SRS estimate of the average coding improvement that will be in use in 2010 for each offered service. This value was then confirmed by the Technology Subcommittee.

6) TRANSMITTED RATE (MODULATION EFFICIENCY). The Motorola White Paper contains data of the historical transmitted rate and a projection of the rate that will be available in the year 2010 based upon an upper limit imposed by signal to noise considerations. The Technology and Spectrum Requirements Subcommittees estimated the average that will be in use in 2010 assuming continued mixed use of older with newer equipment through that time. The video and wide band data average modulation efficiency for 2010 is much higher than that for traditional functions. Since there is little use of those functions now, there will be a much smaller percentage of older technology in use at that time.

7) CHANNEL LOADING. The percent of time which any individual channel is loaded is computed based on the number of servers available to the user group on the system, the average message length, and the delay permitted on the system. A grade of service of 1 percent blockage and an average number of servers of 19 was assumed with erlang C traffic theory. This permitted the computation of the average channel loading for use in this spectrum model. This technique is recommended in the INS White Paper and supported by the Spectrum Requirements Subcommittee as well as the Motorola White Paper on the model.

8) CHANNEL REUSE FACTOR. The factors used in the model for services offered today are based on a study of the reuse in NPSPAC Region 5 today contained in Appendix F. It is assumed there will be little change in the future because the limitation is based on

the operational requirement that many users listen to most messages. The factors used for wide band data and video are based on information obtained in the Focus Groups (Appendix E) and the extrapolation of existing usage.

9) ERROR CODING AND OVERHEAD. The technology improvements projected in the other parameters of the model make every bit of data more important than it has been in the past. The state of the art was shown in the Motorola White Paper on the model to be about 50%, and the Technology and Spectrum Requirements Subcommittees agree that a projection of improvement is not warranted. It is therefore assumed there will be little change by 2010 in this parameter.

9.3.1.6 Compute Spectrum Need. Compute the spectrum need for each of the advanced services to obtain the total spectral need for public safety through the year 2010.

The equation (the MODEL) used to compute the spectrum need for each service in the year 2010 is as follows:

$$MHz = \frac{10000*ERL*POP*PEN*SRC}{COD*RATE*LOAD*REUS*(100-ERR)}$$

The total spectrum need for voice, data, and video by the state and local public safety community is 129.3 MHz through the year 2010 (Appendix G). As indicated in Appendix I, an additional 161 MHz of spectrum is needed to meet state and local public safety microwave requirements. Also, the total spectrum need does not include the channels required for Federal, state, and local interoperable operations. The study indicated that existing Federal spectrum will meet the Federal public safety requirements provided: a) no more Federal spectrum is reallocated to the FCC for commercial use; b) the assumed spectrum-efficient technologies become available; and c) funds are provided by appropriations to implement the spectrum-efficient technologies. As shown in Section 4.2, there is presently 23.2 MHz allocated to the non-Federal public safety community nationwide. Two major manufacturers have stated they will no longer supply equipment in the frequency band from 25-50 MHz, and it is therefore assumed that the 6.3 MHz of spectrum in this band will not be in use in the major metropolitan areas in the 2010 time frame. However, there is existing use of TV channels 14-20 in the major metropolitan areas, and it is assumed the 6.5 MHz in use in Los Angeles will be in use at that time. Therefore, there is 23.2+6.5-6.3=23.4 MHz which must be subtracted from the total need.

In addition, some of the need can be satisfied by using commercial services. For instance, some of the requirement for telephone interconnect may best be served by the cellular services. Local paging networks are also a prime candidate; e.g., in the volunteer fire service for calling the volunteer officers in for service. It has been projected in Section 7.3 that 10% of the spectrum need in 2010 may be satisfied by such commercial services. This is an additional 10.6 MHz that must be subtracted from the total. Therefore, the net spectrum needed for voice, data, and video by the public safety community in the year 2010 is 129.3-23.4-10.6=95.3 MHz.

9.3.1.7 Partial Spectrum Computations. It would be a mistake to attempt to partition the spectrum into blocks for each service or for each category based on the computation made herein. There is an error associated with each computation because of the associated assumptions. In some cases, the amount of spectrum computed will be too large; in others, it will be too small. But, by the central limit theorem, the total will be close to the correct value. Therefore, the total is more accurate than any of the parts.

In addition, consider the need for police communications compared to firefighters and the Emergency Medical Service (EMS). In Los Angeles, there are large summer brush and forest fires. The crime statistics for Los Angeles are, however, relatively lower than the rest of the nation. There is, therefore, a proportionally higher need for communications for firefighters in Los Angeles. In New York, the opposite is true. The crime statistics are relatively high, but the size of typical fires is relatively small. So, in New York, the relative need for communications for police is higher.

In summary, the total computed spectrum need is relatively accurate, and can be used for spectrum planning purposes. Further, there are different spectral requirements for like public safety departments in various areas of the nation. Much more effort would be necessary to carefully quantify the input parameters and regional uses before attempting to plan based upon the separate portions that make up the whole. Therefore, the recommended approach is to use technical flexibility and sharing of frequencies between the various public safety services.

9.3.1.8 Validate the Model. This model has been validated by some members of WG-8 by using it to obtain the results derived in the joint comments of Advanced Mobilecom Technologies, Inc. and Digital Spread Spectrum Technologies, Inc., (footnote 4). Further validation has been accomplished by independent review by other members of the working group. Finally, validation is provided by comparison to other projections of spectrum need for the public safety community that are shown in Section 8.0 of this Subcommittee report. Since the projection contained herein is consistent with those other projections, it is the considered opinion of WG-8 the model used herein is a valid model for the projection of the spectrum need of the public safety community through the year 2010.

9.3.1.9 Effect of Mandates and Incentives on Spectrum Need. It was indicated in Section 7.2 that the spectrum need computed by the model herein is based upon very aggressive projections of technology parameters. However, equipment that is manufactured for the public safety market is designed to meet stringent quality standards. Some of it, therefore, lasts for years after new equipment is available which is more spectrally efficient.

Effective January 1, 1995, NTIA mandated that all new Federal radio systems operating in the 162-174 MHz and 406.1-420 MHz bands must be capable of operating within a 12.5 kHz channel; effective January 1, 1998, new systems in the 138-150.8 MHz band must operate within a 12.5 kHz channel. After January 1, 2005, all systems in the 162-174 MHz band must be capable of operating within a 12.5 kHz channel. This date was extended to January 1, 2008, for all systems in the 138-150.8 MHz and 406.1-420 MHz